PRELIMINARY

ECR #	REV. HIST.	DESCRIPTION	APPROVED	DATE
	A	First release	Allen Houck	11/28/01

TECHNICAL SPECIFICATION

AA121SK22

12.1-INCH SVGA

FOR

INDUSTRIAL APPLICATIONS

	APPROVALS	DATE	OPTREX CORPORATION
ENG.	ALLEN HOUCK	11/28/01	
MKTG.	DALE MAUNU	11/28/01	TFT-LCD MODULE
			12.1-INCH SVGA COLOR
ADI			AA121SK22

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1.   OVERVIEW

1.1.   Description: The AA121SK22 is a 12.1-inch color TFT-LCD (Thin Film Transistor Liquid Crystal Display) module composed of a LCD panel, driver ICs, a control circuit, and a backlight. Input power voltage is either 3.3 or 5.0 V, not including power for the backlight. Both 3.3V-CMOS and 5.0V-CMOS levels are acceptable for logic input. Data and control signal interface is digital CMOS. The display module supports 262,144 colors by applying 18 bits digital data (6 bits per sub pixel, RGB). The display module resolution is 800×600 pixels. Inverter for backlight is not included in this module.

1.2.   General specifications summary table:

ITEM	SPECIFICATION
Display Area (mm)	246.0(H) × 184.5 (V) (12.106-inch diagonal)
Number of Pixels	800 (H) × 600 (V)
Pixel Pitch (mm)	0.3075(H) × 0.3075 (V)
Color Pixel Arrangement	RGB Vertical Stripe
Display Mode	Normally White TN
Number of colors	260 K (6 bits/color)
Luminance	$300(cd/m^2)$ (Typ.)
Viewing Angle	−60 ~ 60° (H), −50 ~ 40° (V) (Typ.)
Wide Viewing Angle Technology	Optical Compensation Film
Surface Treatment	Anti-glare and Hard-coating 3H
Electrical Interface	CMOS(V_I=3~5V)
Optimum Viewing Angle (Contrast)	6 o'clock
Module Size (mm)	280.0 (W) × 210.0 (H) × 12.0 (D)
Module Mass (g)	740
Backlight Unit	2 replaceable CCFLs edge-light (top)

1.3.   Product Disclaimer
The LCD products listed in this document are not suitable for safety related applications that do not have redundant back-up system(s). These LCD products are not designed for use as a single source safety related application, and are not recommended for applications in which human life and/or environment may be affected in the event of the failure of the LCD product. The LCD products should not be used in such things as:
(i)   aircraft navigation or aerospace equipment;
(ii)   nuclear reactor control systems;
(iii)   any application where failure or inaccuracy might cause death or personal injury (e.g., life support systems); or
(iv)   military and submarine critical systems.
The LCD products are designed for typical industrial applications such as, but not are limited to the following: computers, office equipment, industrial controllers, audio and visual equipment, test and measurement devices, communication equipment, point of sale, medical imaging, automotive, and various other consumer products. If there are any questions regarding the use, ability or application of these LCD products, please contact an authorized sales representative.

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2. ABSOLUTE MAXIMUM RATINGS

2.1. Summary Table:

ITEM	SYMBOL	MIN	MAX	UNIT
Power Supply Voltage for LCD	V_{CC}	0	6.0	V
Logic Input Voltage	V_I	0	6.5	V
Operation Temperature *2.2)	T_{op}	0	50	°C
Storage Temperature *2.2)	T_{stg}	−20	60	°C

2.2. Note:

$T_{op,}$ T_{stg} ≤ 40°C: 90%RH max. without condensation
$T_{op,}$ T_{stg} > 40°C: Absolute humidity shall be less than the value of 90%RH at 40°C without condensation.

3. ELECTRICAL CHARACTERISTICS

3.1. Conditions: TFT-LCD module ambient temperature is 25°C

3.2. Summary table:

ITEM		SYMBOL	MIN	Typ.	MAX	UNIT	Remarks
Power Supply Voltage for LCD	3.3V powered	V_{CC}	3.0	3.3	3.6	V	Section 3.4.
	5.0V powered	V_{CC}	4.75	5.0	5.25	V	
Power Supply Current LCD	3.3V powered	I_{CC}	—	335	430	mA	Section 3.4.
	5.0V powered	I_{CC}	—	235	340	mA	
Permissive Input Ripple Voltage		V_{RP}	—	—	100	mVp-p	V_{CC}=+3.3/5.0V
Logic Input Voltage	High	V_{IH}	2.0	—	5.25	V	
	Low	V_{IL}	0	—	0.8	V	

3.3. Backlight
3.3.1. This Backlight has two lamps. The table below shows data for both two lamps.
3.3.2. The TFT-LCD module has four identical lamps operated independently.
3.3.3. Operation of all lamps is required in order to meet all the parameters in the AA121SK22 specification.

ITEM	SYMBOL	MIN	TYP	MAX	UNIT	Remarks
Lamp Voltage	V_L	—	600	—	V	I_L=10.0mA
Lamp Current	I_L	6.0 (3.0mA/Lamp)	10.0 (5.0mA/Lamp)	12.0 (6.0mA/Lamp)	mA	Section 3.4.
Inverter Frequency	FI	30	—	60	kHz	
Starting Lamp Voltage	V_S	1000	—	—	V	Ta=0°C
		1200	—	—	V	Ta=25°C
Lamp Life Time	T_L	50000	—	—	h	I_L=10.0mA Continuous Operation Section 3.4.

3.4. Notes

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3.4.1.   Power and Signals sequence :

t0 $\leq$ 1ms	0 < t4 $\leq$ 50ms
t1 $\leq$ 15ms	400ms $\leq$ t5
0 < t2 $\leq$ 200ms	200ms $\leq$ t6
0 < t3 $\leq$ 1sec	0 < t7

3.4.1.1.   3.3V powered
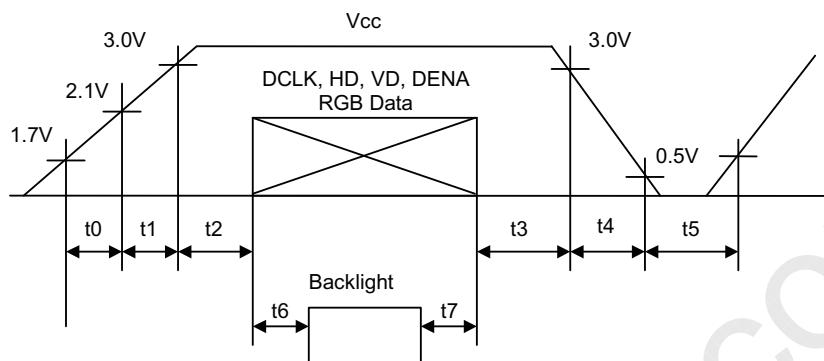
3.4.1.2.   5.0V powered
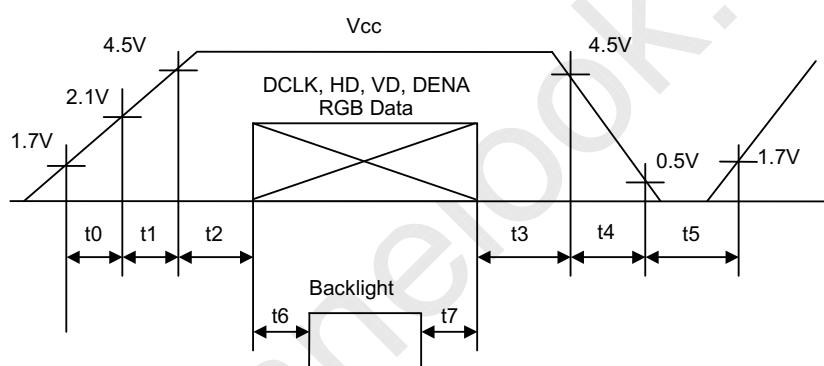
3.4.2. V_{CC}-dip conditions :

3.4.2.1.   3.3V powered

1) When 2.7V $\leq V_{CC}$ < 3.0V
   td $\leq$ 10ms

2) When V_{CC} < 2.7V
   V_{CC}-dip conditions should also follow the Power and Signals sequence.
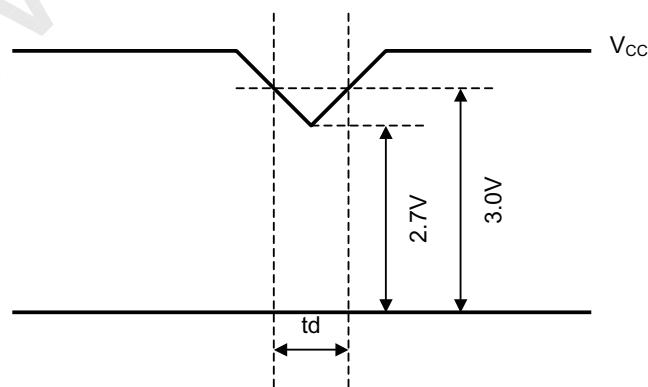
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3.4.2.2.   5.0V powered
1) When $4.2V \leq V_{CC} < 4.5V$
   $td \leq 10ms$
2) When $V_{CC} < 4.2V$
   V_{CC}-dip conditions should also follow the Power and Signals sequence.
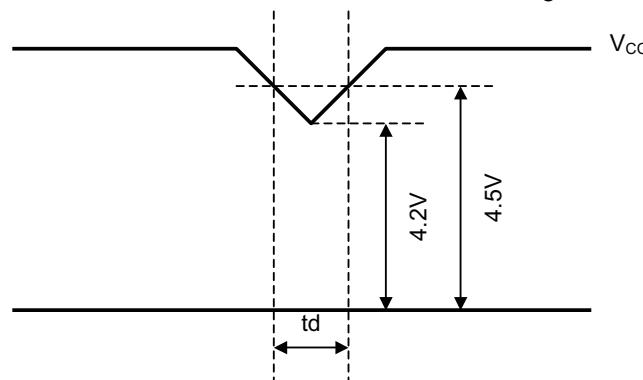
3.4.3.   Test condition for I_{CC} Typical:
64 gray-bar pattern
600 line mode
V_{CC} = +3.3 / 5.0V, f_H=37.9kHz, f_V=60.3Hz, f_{CLK}=40MHz

3.4.4.   Please do not supply 3.6~4.75V constantly as Power Supply Voltage for LCD.
The condition is shown as $t1 \leq 15ms$.

3.4.5.   Lamp current measurement method (The current meter is inserted in low voltage line)
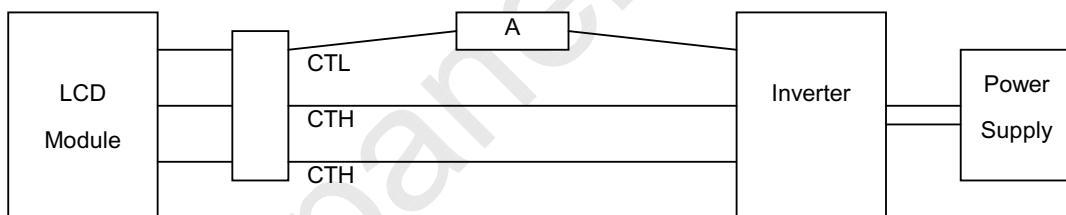
3.4.6.   The operating frequency of the backlight inverter may produce interference with horizontal synchronous frequency. This may cause a horizontal 'beat' to be visible on the display. To avoid this phenomenon, please adjust backlight inverter frequency and keep the inverter as far from module (physically) as possible. Use of shielding between the backlight inverter and the display module is also effective to reduce interference.

3.4.7.   Lamp life time is defined as the time either when the luminance becomes 50% of the initial value under the standard condition, or when the starting lamp voltage does not meet the value specified in this table.

3.4.8.   The life time of the backlight depends on the ambient temperature. The life time will decrease under low/high temperature.

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4. INTERFACE CONNECTORS PIN ASSIGNMENT

4.1.   Input connector type (See paragraph 6.)

4.2.   Input connector pin assignment table:

4.2.1.   Input connector CN1   : DF9B-41P-1V (Hirose)
          Corresponding connector   : DF9B-41S-1V (Hirose)

PIN NO.	SYMBOL	FUNCTION
1	GND	Signal Ground
2	DCLK	Pixel clock
3	GND	Signal Ground
4	HD	Horizontal sync
5	VD	Vertical sync
6	GND	Signal Ground
7	GND	Signal Ground
8	GND	Signal Ground
9	R0	Red data(LSB)
10	R1	Red data
11	R2	Red data
12	GND	Signal Ground
13	R3	Red data
14	R4	Red data
15	R5	Red data(MSB)
16	GND	Signal Ground
17	GND	Signal Ground
18	GND	Signal Ground
19	G0	Green data(LSB)
20	G1	Green data
21	G2	Green data
22	GND	Signal Ground
23	G3	Green data
24	G4	Green data
25	G5	Green data(MSB)
26	GND	Signal Ground
27	GND	Signal Ground
28	GND	Signal Ground
29	B0	Blue data(LSB)
30	B1	Blue data
31	B2	Blue data
32	GND	Signal Ground
33	B3	Blue data
34	B4	Blue data
35	B5	Blue data(MSB)
36	GND	Signal Ground
37	DENA	Data enable
38	NC	Not Connected
39	VCC	+3.3/5.0V Power supply
40	VCC	+3.3/5.0V Power supply
41	TEST	This pin should be open. Test signal output for only internal test use.

Top view of input connector pin assignment
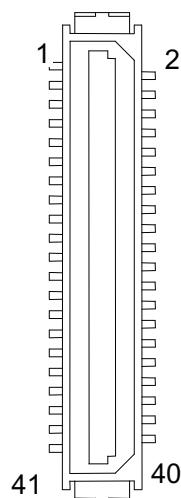
1 ... 2 ... 41 ... 40

*Note: The metal frame of the TFT-LCD module is connected to ground.

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4.2.2.   CN2
     Backlight-side connector: BHR-04VS-1 (JST)
     Inverter-side connector: SM04(4.0)B-BHS-1(JST)

PIN NO.	SYMBOL	FUNCTION
1,2	C_{TH}	V_{BLH} (High voltage)
4	C_{TL}	V_{BLL} (Low voltage)

*Note: The metal frame of the TFT-LCD module is connected to ground.

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5.   INTERFACE TIMING

5.1.   Timing Chart

5.1.1.   Pixel Timing Chart
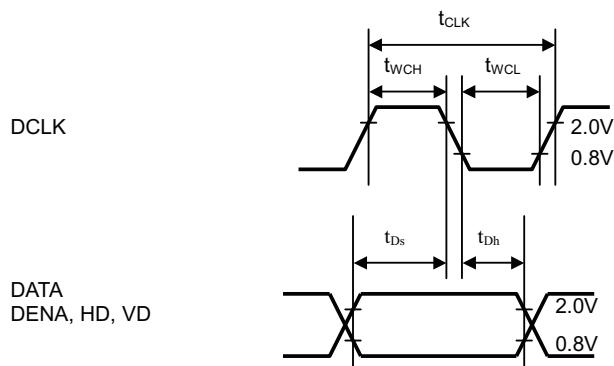
5.1.2.   Horizontal Timing Chart
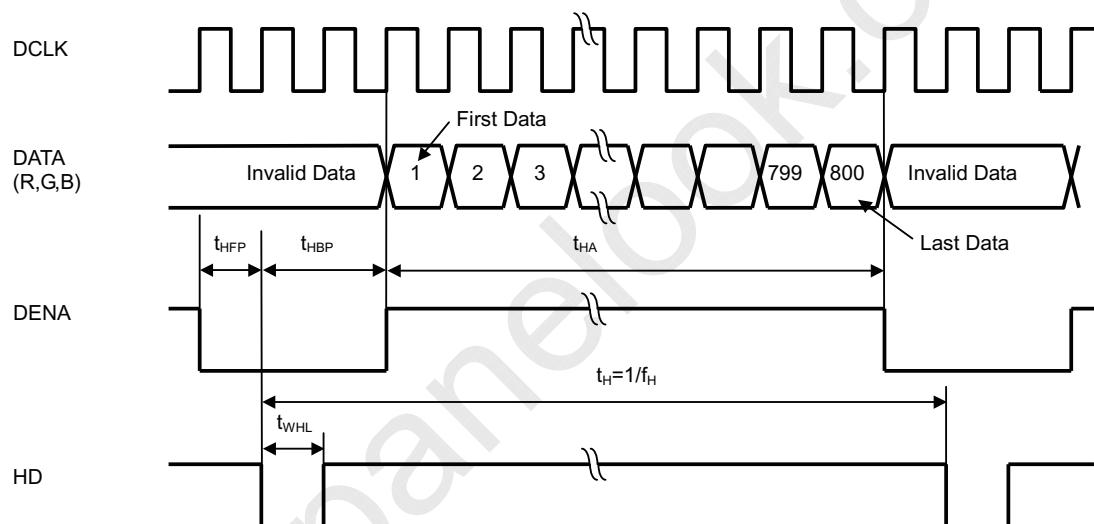
5.1.3.   5.1.3 Vertical Timing Chart
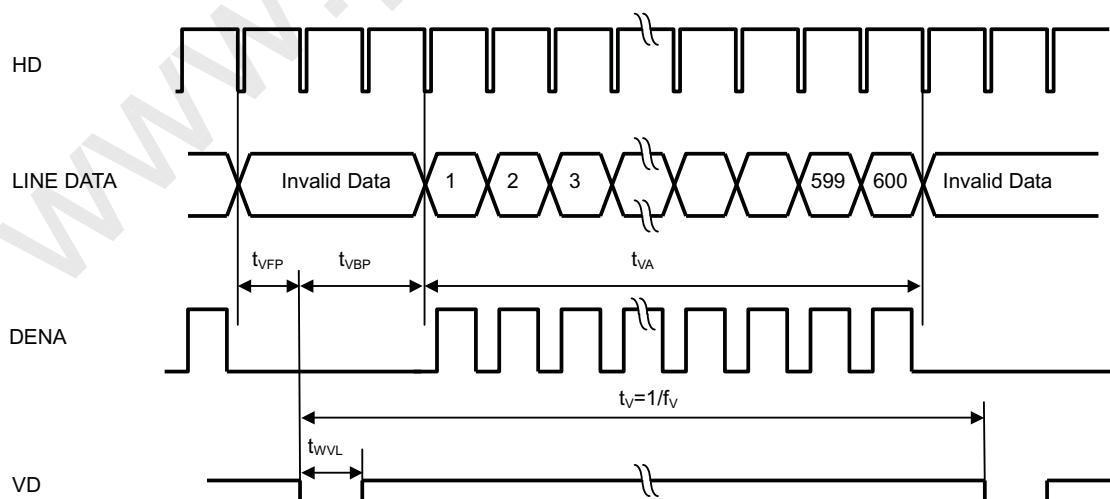
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5.2.   Timing Specification

ITEM		SYMBOL	MIN	TYP	MAX	UNIT
DCLK *	Frequency	f_{CLK}	35	—	40	MHz
	Period	t_{CLK}	25.0	—	27.8	ns
	Low Width	t_{wCL}	10	—	—	ns
	High Width	t_{wCH}	10	—	—	ns
DATA (R, G, B, DENA HD, VD)	Set up Time	t_{DS}	4	—	—	ns
	Hold Time	t_{DH}	4	—	—	ns
DENA	Horizontal Active Time	t_{HA}	800	800	800	t_{CLK}
	Horizontal Front Porch	t_{HFP}	0	—	—	t_{CLK}
	Horizontal Back Porch	t_{HBP}	10	—	—	t_{CLK}
	Vertical Active Time	t_{VA}	600	600	600	t_H
	Vertical Front Porch	t_{VFP}	1	—	—	t_H
	Vertical Back Porch	t_{VBP}	2	—	—	t_H
HD	Frequency	f_H	35.2	37.9	39.2	kHz
	Period	t_H	25.5	26.4	28.4	μs
	Low Width	t_{WHL}	5	—	—	t_{CLK}
VD	Frequency	f_V	55.0	60.3	64.2	Hz
	Period	t_V	15.6	16.6	18.2	ms
	Low Width	t_{WVL}	1	—	—	t_H

*Note 1: DATA is latched at fall edge of DCLK in this specification.
*Note 2: Polarities of HD and VD are negative in this specification.
*Note 3: DENA should always be positive polarity as shown in the timing specification.
*Note 4: DCLK and HD should be applied continuously at the input connector of the TFT-LCD module during operation, subject to Section 3.4.1.

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5.3.   Color Data Assignment

COLOR	INPUT DATA	R DATA						G DATA						B DATA					
		R5 MSB	R4	R3	R2	R1	R0 LSB	G5 MSB	G4	G3	G2	G1	G0 LSB	B5 MSB	B4	B3	B2	B1	B0 LSB
BASIC COLOR	BLACK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED(63)	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	GREEN(63)	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
	BLUE(63)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
	CYAN	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
	MAGENTA	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1
	YELLOW	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
	WHITE	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
RED	RED(0)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED(1)	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	RED(2)	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	⋮																		
	⋮																		
	RED(62)	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED(63)	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
GREEN	GREEN(0)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	GREEN(1)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	GREEN(2)	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	⋮																		
	⋮																		
	GREEN(62)	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0
	GREEN(63)	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
BLUE	BLUE(0)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	BLUE(1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	BLUE(2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	⋮																		
	⋮																		
	BLUE(62)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0
	BLUE(63)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1

5.3.1.   Definitions
Gray scale: Color (n) → n indicates gray scale level.
Data: 1=High, 0=Low

5.3.2.   Data Mapping

D(1,1)	D(2,1)	—	D(X,1)	—	D(799, 1)	D(800, 1)
D(1,2)	D(2,2)	—	D(X,2)	—	D(799, 2)	D(800, 2)
I	I	+	I	+	I	I
D(1,Y)	D(2,Y)	—	D(X,Y)	—	D(799,Y)	D(800, Y)
I	I	+	I	+	I	I
D(1,599)	D(2,599)	—	D(X,599)	—	D(799,599)	D(800, 599)
D(1,600)	D(2,600)	—	D(X,600)	—	D(799, 600)	D(800, 600)

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6.   BLOCK DIAGRAM
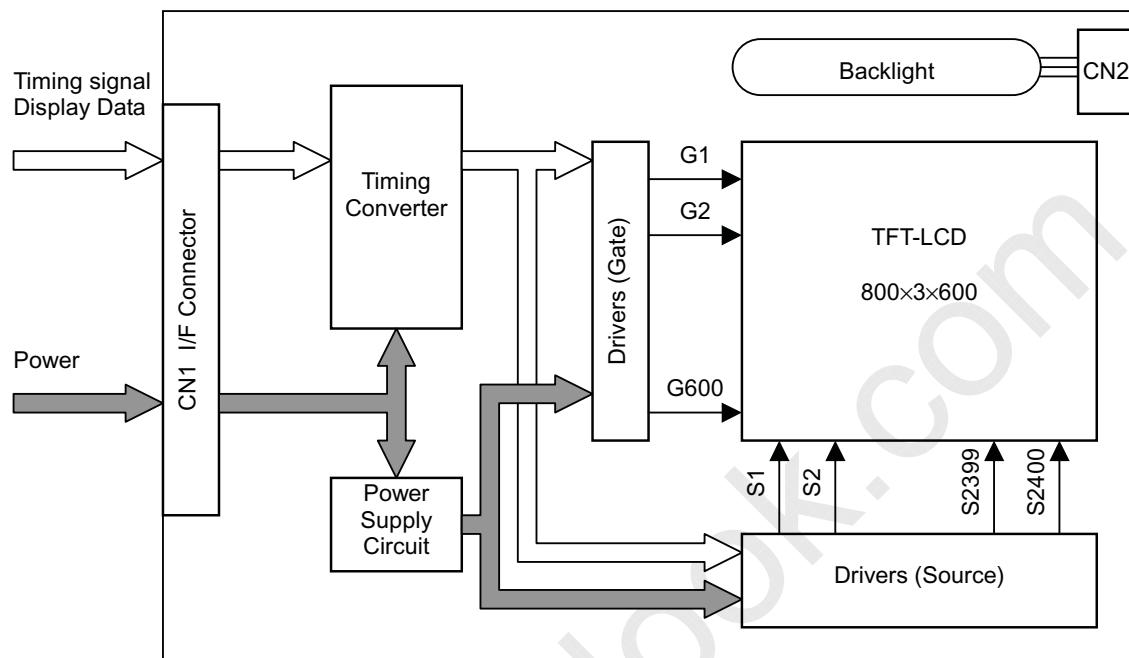
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7.   MECHANICAL SPECIFICATION

7.1.   Front Side Drawing

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UNDEFINED TORELANCES TO BE ±0.5mm
'98/11/18
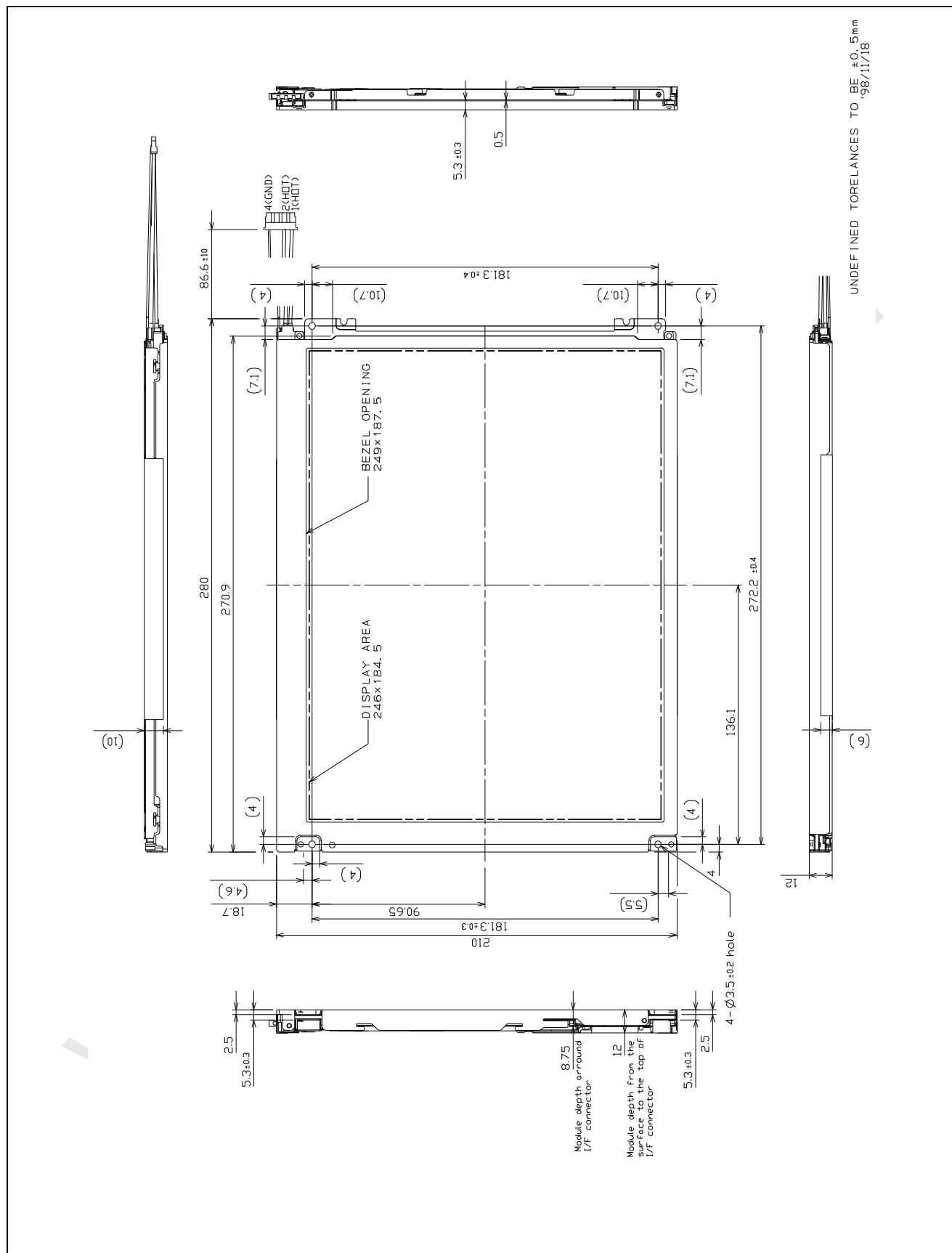
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7.2.　　　Rear Side Drawing

UNDEFINED TORELANCES TO BE ±0.5mm

'98/11/18
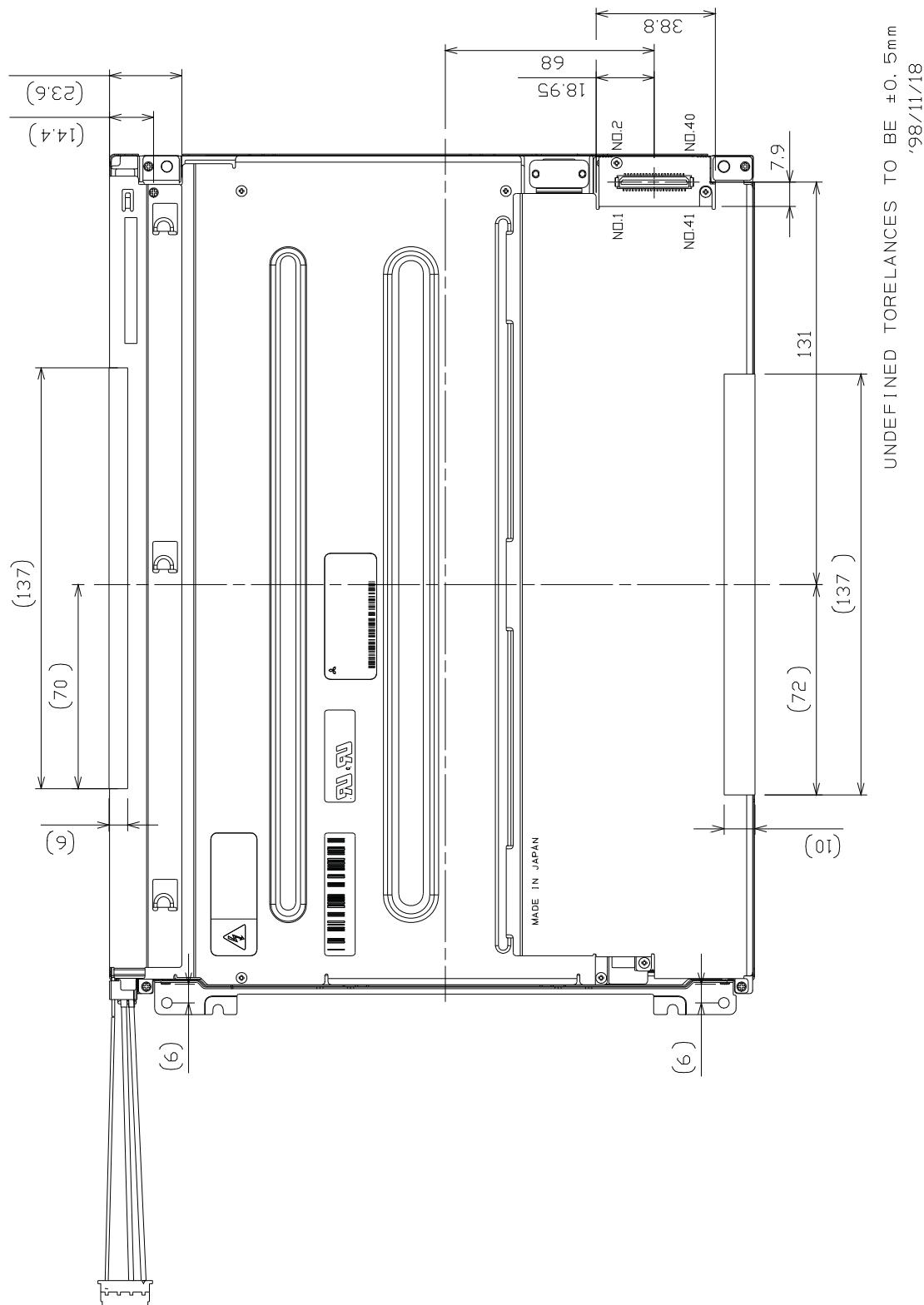
[Note]
We recommend you referring to the detailed drawing for your design.

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Please contact our company sales representative when you need the detailed drawing.

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8. OPTICAL CHARACTERISTICS

8.1. Summary table:

ITEM		SYMBOL	CONDITION	MIN	TYP	MAX	UNIT
Contrast Ratio		CR	$\theta = \phi = 0°$	100	300	—	
Luminance		L_W	$\theta = \phi = 0°$	250	300	—	cd/m^2
Response Time	tr	$\theta = \phi = 0°$	—	20	40	ms
	tf	$\theta = \phi = 0°$	—	30	50	ms
Viewing Angle	Horizontal	ϕ	CR $\geq$ 10	−50~50	−60~60	—	°
	Vertical	θ		−40~30	−50~40	—	°
	Horizontal	ϕ	$L_W \geq 70\%$	—	−20~20	—	°
	Vertical	θ		—	−20~20	—	°
Image Sticking		tis	2 hours	—	—	2	s
Color Coordinates	Red	Rx	$\theta = \phi = 0°$	0.532	0.562	0.592	—
		Ry		0.316	0.346	0.376	
	Green	Gx		0.296	0.326	0.356	
		Gy		0.519	0.549	0.579	
	Blue	Bx		0.137	0.167	0.197	
		By		0.151	0.181	0.211	
	White	Bx		0.296	0.326	0.356	
		By		0.338	0.368	0.398	

These items are measured using BM-5A (TOPCON) or LCD7000 (Otsuka Electronic) under the dark room condition (no ambient light).

*); Condition: I_L=10.0mA, Inverter frequency: 47kHz
Ambient Temperature 25°C, V_{CC}=3.3/5.0V, signal timings are typical values in section 5.

Definitions of these measurement items are as follows:

1) Definition of Contrast Ratio
CR=ON (White) Luminance/OFF (Black) Luminance: average of 5 points below

2) Definition of Luminance

L_W=ON (White) Luminance: average of 5 points below
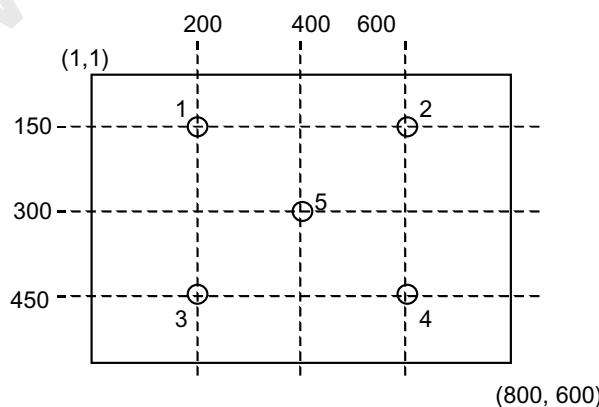
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8.2.   Definitions
8.2.1.   Contrast Ratio CR = ON (White) Luminance / OFF (Black) Luminance
8.2.2.   Viewing Angle (θ , φ) - See drawing below:

θ

φ

Upper (+)

Left (-)

Right (+)

LCD
panel

Lower (-)
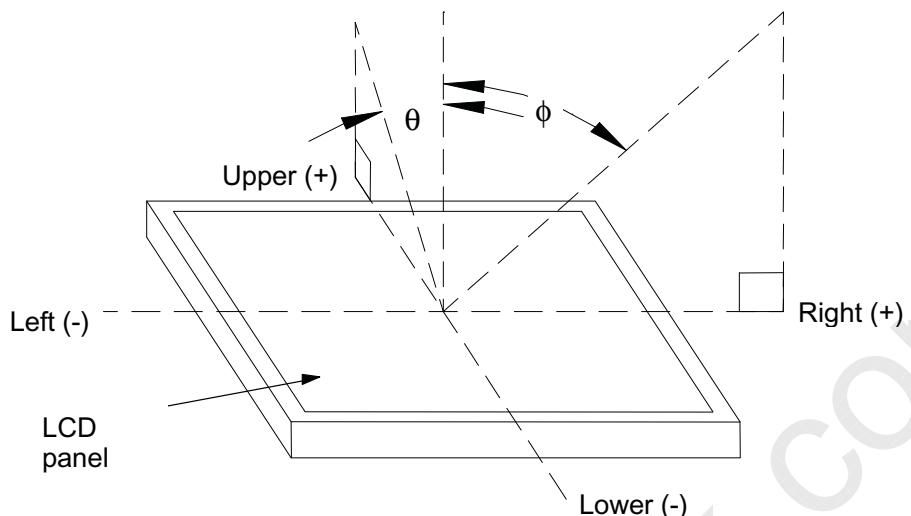
8.2.3.   Definition of Response Time tr and tf:

White

90%   90%

10%   10%

tr   Black
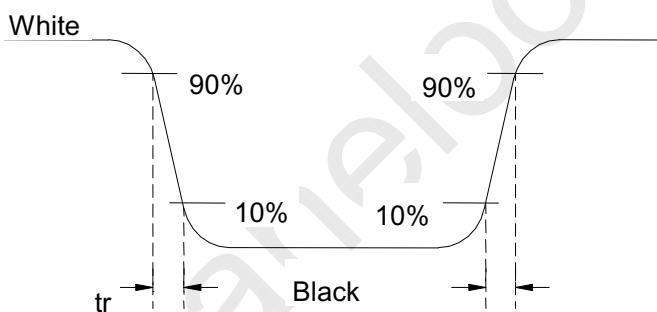
8.2.4.   Test Pattern for Image Sticking Test
Continuously display the test pattern shown in the figure below for two-hours. Then display a
completely white screen. The previous image shall not persist more than two seconds at 25°C.

Cols 388-402

White
Area

Rows 298-302

Black
Lines
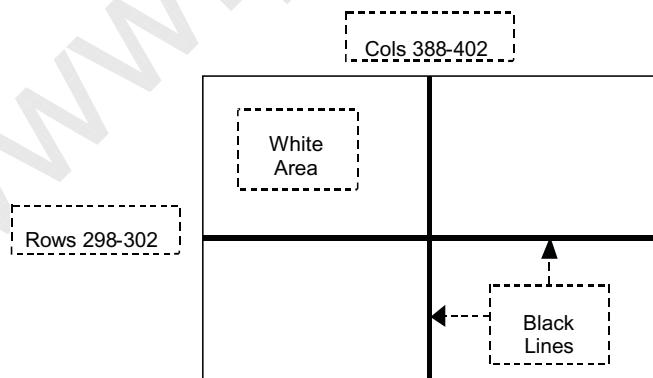
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9.   RELIABILITY TEST CONDITIONS

9.1.   Temperature and Humidity

TEST ITEM	CONDITIONS
High Temperature and High Humidity Operation	40°C, 90%RH, 240 hours (No condensation)
Thermal Shock	Between –20°C (1 hour) and 60°C (1 hour) 5 cycles
High Temperature Storage	60°C, 96 hours
Low Temperature Storage	–20°C, 96 hours

9.2.   Shock and Vibration

TEST ITEM	CONDITIONS
Shock (non-operating)	Shock level: 1470 m/s^2 (150G) Waveform: half sinusoidal wave, 2 ms Number of shocks: one shock input in each direction of three mutually perpendicular axes for a total of six shock inputs
Vibration (non-operating)	Vibration level: 9.8 m/s^2 (1.0G) Waveform: sinusoidal Frequency range: 5 to 500 Hz Frequency sweep rate: 0.5 octave/min Duration: one sweep from 5 to 500 to 5Hz in each of three mutually perpendicular axes (each x,y,z axis: 1 hour, total 3 hours)

9.3.   Judgment Standard – Pass/Fail criteria for reliability tests is defined as follows:
Pass : Normal display image with no obvious non-uniformity and no line defect.
Fail : No display image, obvious non-uniformity, or line defect.

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10.   HANDLING PRECAUTIONS FOR TFT-LCD MODULE - Please observe the recommendations included in this paragraph when handling the TFT-LCD modules !

10.1.   ASSEMBLY PRECAUTIONS

10.1.1.   Please use the mounting hole on the module corners for installation and avoid bending or wrenching LCD during assembly process. Do not drop, bend or twist the TFT-LCD module during handling.

10.1.2.   Guidelines for designing the TFT-LCD module enclosure:

10.1.2.1.   Housing case must be designed carefully so as not to put stresses on LCD all sides and not to wrench module. Mechanical stress to the TFT-LCD module may degrade the reliability and overall performances of the display (like luminance uniformity degradation…etc.).

10.1.2.2.   Keep sufficient clearance between LCD module back surface and housing when the LCD module is mounted. Approximately 1.0 mm of the clearance in the design is recommended taking into account the tolerance of LCD module thickness and mounting structure height on the housing.

10.1.2.3.   When some parts, such as FPC cable and ferrite plate, are installed underneath the LCD module, still sufficient clearance is required, such as 0.5mm. This clearance is to be reconsidered when additional parts are inserted for EMI countermeasures.

10.1.2.4.   Choose carefully the inverter location to avoid any stress to the lamp cable. The lamp cable also should not interfere with the module installation into the enclosure.

10.1.2.5.   Keep sufficient clearance between LCD module and the others components, such as inverter and speaker so as not to interfere with the LCD module. Approximately 1.0 mm of the clearance in the design is recommended.

10.1.2.6.   Please connect the metal frame of the module to GND in order to minimize the effect of external noise and EMI.

10.1.3.   Do not apply pressure or scratch LCD panel surface with anything hard. Do not soil LCD panel surface by touching with bare hands. (The anti-glare surface treatment is only effective when the module surface of the display is clean and unmarred.)

10.1.4.   Do not apply pressure on any parts on the rear side such as source TCP, gate TCP, control circuit board and FPCs during handling LCD module.

10.1.5.   Wipe off LCD panel surface with absorbent cotton or soft cloth to clean the surface.

10.1.6.   Wipe off immediately any liquids which may have accidentally being sprayed on LCD panel surface. Droplets on the LCD panel surface may alter the quality of the image.

10.1.7.   Do not disassemble the TFT-LCD module for any reasons. By doing so you void the warranty of the TFT-LCD module and is very likely that the performances will be degraded considerably.

10.1.8.   Do not touch metal frames with bare hands and soiled gloves. If fingerprints or dirt are not cleaned immediately with solvent it is very likely that permanent marks will be left on the metal surfaces.

10.1.9.   Disconnect the lamp wires before handling the inverter. Otherwise, it is possible to damage the lamp and or the lamp wires by pulling it together with the inverter.

10.2.   OPERATING PRECAUTIONS

10.2.1.   Turn off the power supply before connecting and disconnecting signal input cable.

10.2.2.   Do not change the setting of the adjustable resistors on TFT-LCD module subassemblies. The adjustable resistors are properly set at the factory and any deviation from the factory setting will compromise the performances of the TFT-LCD module.

10.2.3.   When evaluating the optical characteristics of the display please note that will take longer time for the backlight to stabilize if the ambient temperature is at the lower end of the temperature range.

10.2.4.   Sudden changes of the ambient temperature may cause condensation on various surfaces of the TFT-LCD module and degrade the overall performances until the surfaces become dry again.

10.2.5.   Follow-up the general safety rules applying to generic electronic products.

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10.3. PRECAUTIONS WITH ELECTRONICS

10.3.1. This LCD module uses CMOS integrated circuits and other components subject to be affected by electrostatic discharges. Use ESD protection equipment and follow all ESD safety procedures when handling the TFT-LCD modules.

10.3.2. Please remove protection film very slowly from the surface of LCD module to prevent electrostatic discharge. It is recommended to lift the protection film starting from the lower left corner of the module, and pulling diagonally toward the upper right corner.

10.4. STORAGE PRECAUTIONS

10.4.1. Do not leave the LCDs in the environment of high humidity and high temperature.

10.4.2. Do not expose the TFT-LCD modules to temperatures below $-20°C$.

10.5. SAFETY PRECAUTIONS

10.5.1. When disposing LCDs it is recommended to break them into pieces. The broken pieces should be washed with solvents such as acetone and ethanol. The residual solvent from this process should be burned.

10.5.2. If any liquid leaks out of a damaged glass cell and comes in contact with the hands, wash it off thoroughly with soap and water.

10.6. OTHERS

10.6.1. Exposing the TFT-LCD module to strong incident light may negatively affect the display characteristics because of polarizer film, color filter, and other materials degradation. Do not expose LCD module to direct sunlight or light with strong ultraviolet content.

10.6.2. Avoid any contact of the TFT-LCD module front surface with other objects or materials.

10.7. PACKAGING AND SHIPPING

10.7.1. Packaging box and inner case for LCD are designed to protect the LCDs from the damage or scratching during transportation. Do not open the packaging box unnecessarily.

10.7.2. Do not stack more than 5 boxes on top of each other because stack of 5 is maximum designed limit. Do not turn over the boxes.

10.7.3. Avoid excessive shock; the shipping boxes are not designed to be thrown. Excessive vibrations can also damage the boxes and the TFT-LCD modules inside.

10.7.4. Packaging box and the inner structures of it are made of cardboard. Avoid having the boxes in contact with water or in high humidity environment which may cause the carton to become soft, or to break, damaging the TFT-LCD modules inside.

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